**UCRL-JC-123054 Abs Rev. 1**

International Topical Meeting on Probabilistic Safety Assessment
Park City, Utah, Sept 29-Oct 3, 1996

# Safety Analysis of the National Ignition Facility*

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The National Ignition Facility (NIF) is a proposed U.S. Department of Energy inertial confinement laser fusion facility. The candidate sites for locating the NIF are: Los Alamos National Laboratory, Lawrence Livermore National Laboratory (preferred site), Sandia National Laboratory, and the Nevada Test Site. The mission of the NIF is to achieve inertial confinement fusion (ICF) ignition, access physical conditions in matter of interest to nuclear weapons physics, provide an above ground simulation capability for nuclear weapons effects testing, and contribute to the development of inertial fusion for electrical power production.

To achieve this mission, the NIF laser will require an energy of 1.8 MJ and a power of 500 TW. The laser will be comprised of 192 individual beamlets, which will be focused onto a target suspended in the center of a 10 m diameter, evacuated, spherical, aluminum [Al5053] target chamber. ICF targets intended to achieve ignition and yield will contain an equimolar mixture of deuterium and tritium, with up to 15 Ci of tritium per target. The laser energy will be delivered to the target over a short period of time (~ 20 ns), causing compression and heating to thermonuclear fusion burn conditions. Not all experiments will be "burn" shots, perhaps 25% of 1200 annual shots. These experiments release neutrons, debris, and x-rays. Unburned tritium will be exhausted from the target chamber to the processing and molecular sieve collection system. The tritium inventory in this system will be limited by regular exchange of the molecular sieve bed, such that the total facility inventory will be more than 500 Ci. Emitted neutrons will activate the target chamber, or they will travel through the target chamber structure and shielding, or through penetrations, and enter

* Work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

the target chamber room. Here, they will activate the supporting structure for the target chamber, the concrete and rebar in the walls, and the gases in the room air. The level of neutron activation is a function of the shot yield, the number of shots, and their frequency. Radioactivity levels of long-lived nuclides, which are an issue for waste disposal and build-up of residual decay radiation, will be fairly low. Shorter-lived nuclides (e.g. $^{27}Mg$ (half-life = 9.5 min), and $^{24}Na$ (half-life = 15 h)) will present a greater radiological hazard in the target room to reentry personnel after a high-yielding shot. These short-lived nuclides will decay significantly between shots, such that the initial inventories are primarily a function of shot yield. The maximum shot yield is expected to be 20 MJ (with a maximum credible yield of 45 MJ ($1.6x10^{19}$ D-T neutrons)).

The facility has been classified as a radiological, low hazard facility on the basis of a preliminary hazards analysis and according to the DOE methodology for facility classification. This requires that a safety analysis be prepared under DOE Order 5481.1B, Safety Analysis and Review System. A Preliminary Safety Analysis is currently underway, and the PSAR will be completed later in 1996.

The safety analysis process began with identification of hazards. These primarily consist of the laser, tritium handling, prompt radiation generated during shots, and neutron activated material, including structures in the immediate area and air in the target chamber room. Six foot thick concrete walls reduce radiation levels outside the facility such that site boundary exposures from prompt radiation (approximately 340 m away at the preferred site) will be less than about 0.2 mrem/yr for the expected shot sequence. Airborne releases of activated gases and tritium could add about 0.1 mrem/yr to this at the site boundary. Routine maintenance occupational exposures will be controlled by delay time before access, shielding, including temporary shielding as needed, work time constraints, remote operations, personal protective equipment, training, and proper procedures. The NIF utilizes a very powerful laser with an associated large electrical energy storage and discharge system, which present significant electrical and optical hazards. Controls to prevent accidents from laser operation include: physical barriers, interlocks, protective eye equipment, visual and audible alarms, video surveillance, personnel accountability, training, and specific procedures.

Accidents associated with the operation of the NIF were also identified as part of the safety analysis process. Consistent with DOE's graded approach to safety analysis, where the level of effort associated with the safety analysis should be graded with the level of hazard, the NIF safety analyses have been deterministic rather than probabilistic assessments. The consequences of a few bounding accidents were analyzed quantitatively to define the operating envelope for NIF. Event frequencies were evaluated qualitatively and were primarily judgment based. The maximum consequence to the public from any postulated radiological accident is several hundred mrem+, and this is associated with an extremely unlikely event.

Chemical hazards associated with the NIF were also evaluated. These include solvents used for cleaning, ablated material formed in the target chamber, and materials such as mercury used in electrical equipment. Routine emissions of any hazardous materials are expected to be very low. Any accidental releases result in negligible offsite consequences.

In addition to identifying hazards and evaluating impacts, the safety analysis serves the purpose of helping identify safer design alternatives and controls for hazards. In this way, the risks associated with operation of the NIF will be minimized.

This work was performed under the auspices of the U.S. Dept of Energy at LLNL under contract no. W-7405-Eng-48.

+ Analysis is ongoing at the time of preparation of this summary. Thus, exact values cannot be provided at this time.